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REARING THE CIGARETTE BEETLE FOR EXPERIMENTAL USE

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INTRODUCTION

For several years the cigarette beetle (Lasioderma serricorne Fab.) has been reared at the Richmond laboratory of the Bureau of Entomology and Plant Quarantine for use in fumigation experiments. Methods of rearing, handling, and maintaining the insects on whole corn meal and on tobacco have been developed and are described in this paper.

DESCRIPTION OF THE REARING ROOM

Construction

The room used at the laboratory for rearing the beetle was 13 by 11½ by 8 feet and contained 1,196 cubic feet. The side walls were insulated with fabricated boards one-half inch thick, and the cracks between boards were covered with wooden slats. The floor was made of tongued and grooved boards and was thoroughly coated with paint and shellac. The door opening into the room was insulated by fastening a layer of weather strip around the edges.

Shelves were built against the walls for accomodating the rearing containers. A small table that could be easily moved from one part of the room to another served as a convenient transport and work bench. An interior view of the rearing room is shown in figure 1.

Temperature Control

The desired temperature of the room was maintained by an electric heater of the blower type, operated through a thermostat. It was found that a constant temperature of 82° F. gave good results when rearing the insects on corn meal or tobacco. In illustration of the uniform temperatures maintained in the rearing room, a study of hygrothermograph records shows that for a typical week in winter the temperature varied less than 1° above or below 82° F., while in an adjacent unheated room during the same period the temperature range was from 43° to 59° with an average of 51.7° F. The heater was placed so that the warm air flowed from it into the revolving screen drum of the humidifier. (Cost of heater and thermostat, approximately $20.)

Humidity Apparatus

The cigarette beetle was reared at rather low humidities (20 to 30 percent) when corn meal or dry yeast was used as food, although at higher humidities (65 to 70 percent) better results were obtained. However, when tobacco was used as food, the higher humidity was necessary. The results obtained when the relative humidity ranged from 65 to 70 percent were satisfactory. Tobacco kept in these atmospheric conditions had a moisture content of from 11 to 15 percent. At low humidities tobacco lost its moisture content rapidly and became dry and brittle, and in this condition was not readily eaten by newly hatched larvae.

The desired relative humidity was maintained by rotating a 4-mesh galvanized screen drum through a pan of water. In order to increase the rate of evaporation and to provide for the circulation of air as it was humidified, an electrically operated fan was installed at one end of the screen to force a stream of air into it. The opposite end of the drum was closed. The air was thereby forced to leave the drum through the wet screen. The relative humidity maintained during a typical week in winter, as shown by hygrothermograph records, varied less than 2 percent above or below 70 percent, while in an unheated room adjacent the percentages varied from 41 to 58 and the average for the week was 49.1 percent. The temperature and humidity apparatus is shown in operation in figure 2, and a sketch of the device is shown in figure 3.

Description of parts

The apparatus for maintaining relative humidity consisted of three parts, as follows:

1. Screen-wire drum with pan for water. The screen-wire drum, 20½ inches in length, 12 inches in diameter, and covered with galvanized screen wire having 4 meshes per linear inch, was soldered to a frame made of small metal laths 3/16 inch thick and 1 inch wide. The axis of the cylinder was a metal rod one-half inch in diameter. The ends of the axis were supported by upright brackets provided on each end of the sheet-metal pan. One end of the axis was attached to a drive pulley (12 inches in diameter).

The pan for holding the water in which the screen cylinder operated was 22¼ inches wide, 24½ inches long, and 3 inches deep and was constructed of sheet metal. The pan was 1 inch longer than the cylinder, in order to allow sufficient clearance between the upright brackets that supported the axis of the cylinder. The cylinder was adjusted so that the drum could revolve without striking the bottom of the pan. The water in the pan should rise at least 1 inch above the lowest surface of the drum in order to insure a good coverage of the screen when the cylinder revolves. The cylinder should revolve at the rate of about 30 r. p. m. One end of the cylinder was left open to receive a stream of air, as described below. The other end was closed with a piece of

sheet iron welded to the frame. By closing the end of the cylinder, the air was forced to pass out through the wire drum, thereby causing it to take up moisture. The sheet-metal pan and screen-wire cylinder were constructed by a local tinsmith. (Approximate cost of screen-wire drum and pan for containing water, $10.)

2. Small electric motor (sewing machine type) with foot-pedal switch. This motor was used to revolve the screen cylinder mounted over the pan of water. A small belt of the type ordinarily used on sewing machines was used to drive the screen drum.

The speed of the motor was regulated satisfactorily by means of a foot-pedal switch of the type used with sewing machine motors. This switch obviated the necessity of conducting the power through various sized pulleys in order to secure a desired speed. An adjustable clamp was used to maintain the proper pressure on the foot-pedal. The switch was attached to a humidistat which automatically started the cylinder revolving through the water when the moisture in the air dropped below the desired level. (Approximate cost, $15.)

3. A 1/30 horsepower motor with two 12-inch fan blades. This motor was mounted on a firm base at the end of the screen cylinder. Approximately 1-inch clearance was left between the fan blades and the cylinder to allow them to operate without danger of the blades striking the pan or the supports. The fan forced a steady stream of air over and through the revolving wet cylinder, and a rapid evaporation of moisture resulted. (Approximate cost, $11.)

METHODS EMPLOYED IN REARING

Foods

Whole corn meal

It was found that the cigarette beetle could be grown with good success on whole corn meal.

For rearing containers one-pint glass jars were used (fig. 4, A). Each jar was filled from one-half to two-thirds full with corn meal that had been sterilized in an electric oven for 4 hours at 140° F. This sterilization was a precautionary measure taken to rid the meal of any possible infestation of the mite *Pediculoides ventricosus* Newp., which preys on larvae of the cigarette beetle. The meal was pressed down firmly in the jar until the latter could be turned upside down without danger of the meal pouring out. This procedure of packing greatly increased the chances of obtaining good results. In the first place, packing gave a good hard surface which seemed to be more suitable to the beetles than a soft surface. The beetles crawled through soft corn meal with difficulty and undoubtedly expended a large amount of energy that might otherwise have been used in reproduction. Sec-

ondly, the adults laid eggs more readily when a firm surface was present for inserting the ovipositor. From 75 to 250 adult beetles were placed in each jar, and the jar was covered with a piece of finely woven cotton sheeting held in place with a rubber band; it was then set aside and required no further attention.

The eggs were deposited just beneath the surface of the meal. The young larvae upon hatching exhibited no definite path of movement but usually fed downwards or outwards. They did not return to the surface, unless extremely crowded conditions existed in the container, until they became full grown and were ready to construct the pupal cells, at which time they made their way toward the upper surface. The first cells formed were usually attached to the sides of the glass jar. The entire upper part of the corn meal usually became a mass of cells joined together and sometimes several layers thick. This tendency of the larvae to form the cells in the upper part of the corn meal and as near to the surface as possible without becoming exposed was always evident when the beetle was reared on corn meal or any other finely ground or pulverized food, such as dry yeast, cottonseed meal, etc.

Unmanufactured tobacco

For rearing the cigarette beetle on tobacco, the one-pint glass jar was found satisfactory (fig. 4, B). Each jar was filled about two-thirds full with tobacco cut into pieces that would fit easily into the jar. The Turkish type tobacco leaves were small and required no cutting. The tobacco was pressed down rather tightly, but not enough to prevent the beetles from crawling about in it to lay eggs. Each jar, after being supplied with several hundred adults, was covered with finely woven cloth held in place by a rubber band.

The moisture content of tobacco used for rearing the beetles should be carefully maintained. Hard brittle tobaccos were unsatisfactory as food for larvae. A moisture content of 11 to 15 percent in the leaf produced good cultures of insects. This moisture content prevailed in tobacco kept in an atmosphere with a relative humidity of 65 to 70 percent, the exact moisture content depending, of course, upon the type and nature of the tobacco. The figures given apply to domestic flue-cured and imported Turkish type tobaccos when the temperature was approximately 82° F.

Handling the Different Stages

Eggs for experimental use were obtained by enclosing beetles of both sexes in a small container, such as a petri dish, and supplying them with the dried, rugose midribs of tobacco leaves, which afforded folds and crevices in which the females deposited eggs. If it was desirable to remove the eggs from the stems, to which they were glued at the time of oviposition by a mucilaginous secretion of the female, this was accomplished by detaching the eggs with the aid of a dissect-

ing needle. Various artificial media were improvised for securing eggs, such as small strips of blotting paper clipped together to form a crevice, and small balls of lint cotton tightly wadded. No artificial medium for oviposition seemed to be as attractive to the females as food substances for young larvae.

Newly hatched larvae were easily handled with a small camel's-hair brush or with a dissecting needle. At the time of hatching and throughout the period of larval development they were covered with hairs which easily adhered to the brush. The young larvae showed a tendency to grasp at any object that touched them, and because of this habit were easily transferred with either the brush or dissecting needle. Care had to be exercised, however, in disengaging them from brush or needle.

When the larvae became about one-third grown or larger they were easily handled with forceps. If reared in a finely pulverized food material, such as corn meal, they were first segregated from the food material by the use of sifters and then counted or handled with the aid of tweezers.

Larvae were removed from tobacco by holding the leaves over a pan and pulling them apart, at the same time shaking the leaves gently, so that the larvae dropped into the pan.

No evidences of cannibalism were observed.

The full-grown larva encloses itself in a cell made of particles of food cemented together with a mucilaginous secretion. In this cell the prepupa is formed and later the pupa.

These cells were removed from pulverized food material by sifting, but if larvae not yet in pupal cells were present, sifting removed them also. The cells were opened with extreme care because the prepupal and pupal stages were easily injured.

In tobacco the pupal cells were usually glued to the leaves and could not be easily dislodged by shaking. They had to be removed individually with forceps, an operation that required much time because the color of the cells blended with that of the tobacco.

The adult is a small, dark-brown beetle from 2 to 3 millimeters in length. It is a good crawler, but is not very active at high temperatures or when suddenly exposed to light. It flies easily, but rarely resorts to this means of locomotion under laboratory conditions. The beetles, when enclosed in small spaces, such as the breeding jars, showed no signs of restlessness, except when they became crowded.

Adult beetles emerging from pulverized food material, such as corn meal, were separated to some extent by sifting. But this method did not prove entirely satisfactory, as larvae and pupal cells were

usually present and did not easily separate from the adults by sifting. In lieu of sifting, it was found that a band of corrugated cardboard, 1 inch wide, when tightly rolled into a cylinder about 1-1/2 inches in diameter and put in the containers, attracted the beetles. The adults, seeking a place to rest quietly during the preoviposition period, collected in the crevices. The cylinders of corrugated cardboard were removed at intervals, or when adults were needed for experimental use, and the beetles were removed by holding them over a container and tapping. The beetles were easily dislodged.

The removal of adults from tobacco cultures was not very satisfactorily accomplished, because the tobacco usually contained immature stages, which, if the shaking method was used, presented the same disadvantage encountered in sifting adults from pulverized food material; i. e., there would be a mixture of stages collected on the sifter. The corrugated cardboard method was used to some extent, but was not highly satisfactory. The tobacco afforded to some extent the protection provided by the corrugated cardboard. The beetles were able to crawl about in the tobacco, whereas in pulverized food materials the adult beetles never exhibited a tendency to burrow back into the food after emergence. When the tobacco used was compressed into very tight bundles or bales, a larger percentage of the beetles would collect in the corrugated cardboard cylinders.

FACTORS WHICH REDUCE POPULATIONS

Predators and Parasites

The greatest single source of annoyance from enemies of the cigarette beetle was the predacious itch mite, *Pediculoides ventricosus*, which preyed on the larval and pupal stages. It was capable of destroying thriving cultures in a very short time. Its ravages were avoided by using one-pint glass jars. In these small containers infestations of the mite could be observed and destroyed before they had spread. The disposal of old cultures as soon as they began to show a decline in productivity was also an important precaution to observe in conbating mites. The sheeting used to cover the jars was tightly woven, and strong rubber bands were used to hold it in place in order to minimize the chances of infestation from outside sources. Jars containing corn meal were not left open or stored in the rearing room.

Other predators that occasionally gained entrance to cultures are the cadelle (*Tenebroides mauritanicus* L.) and an unidentified predacious mite that feeds on the eggs of the beetle. The precautionary measures applied for the control and prevention of *Pediculoides* infestations also controlled these pests.

The hymenopterous parasite *Aplastomorpha calandrae*. How occasionally infested cultures. Precautionary measures taken against mites also prevented losses that might have been caused by this species.

Miscellaneous Factors

Occasionally larvae died from a condition which was apparently pathogenic. The malady seemed to appear sporadically. Cultures were immediately destroyed when it appeared, and, fortunately, it never became a serious factor.

In the rearing work best results were obtained with flue-cured tobacco and with imported Turkish tobacco, the latter proving more satisfactory. Each of these types has a comparatively low nicotine content and a comparatively high sugar content. Burley tobacco, which contained a high percentage of nicotine and very little sugar, proved unsatisfactory as food in the rearing containers.

DISCUSSION

The cigarette beetle, which has been little employed as an experimental animal, has many characteristics that recommend it for experimental use. Among these is its ability to subsist on a wide variety of food materials, a fact which makes it particularly suitable for use in investigations on insect nutrition. The beetle is a feeder on stored products, and therefore the necessity and expense of maintaining growing plants are eliminated. It is distributed generally throughout the world and is easily obtainable, especially in commercial storage centers of such commodities as tobacco, spices, and other dried vegetable materials.

The habits and life history of the species also make it adaptable for experimental purposes. It has a relatively short life cycle and is a prolific breeder capable of reproducing continuously without the necessity of undergoing dormancy periods. When reared under artificial conditions and given a reasonable amount of attention, the insect can be reared in large numbers in a very small space. The species is not easily excited and can be handled with ease under artificial rearing conditions, since the insect seems to have no difficulty in adjusting itself to such an environment. It is attacked by few natural enemies.

It is believed that the habits and characteristics of this species recommend it to investigators in many fields of insect research, and that eventually it will assume the status of such standard experimental insects as the flour beetle, the rice weevil, and the Indian-meal moth.

Figure 1.--Interior view of room used in rearing the cigarette beetle.

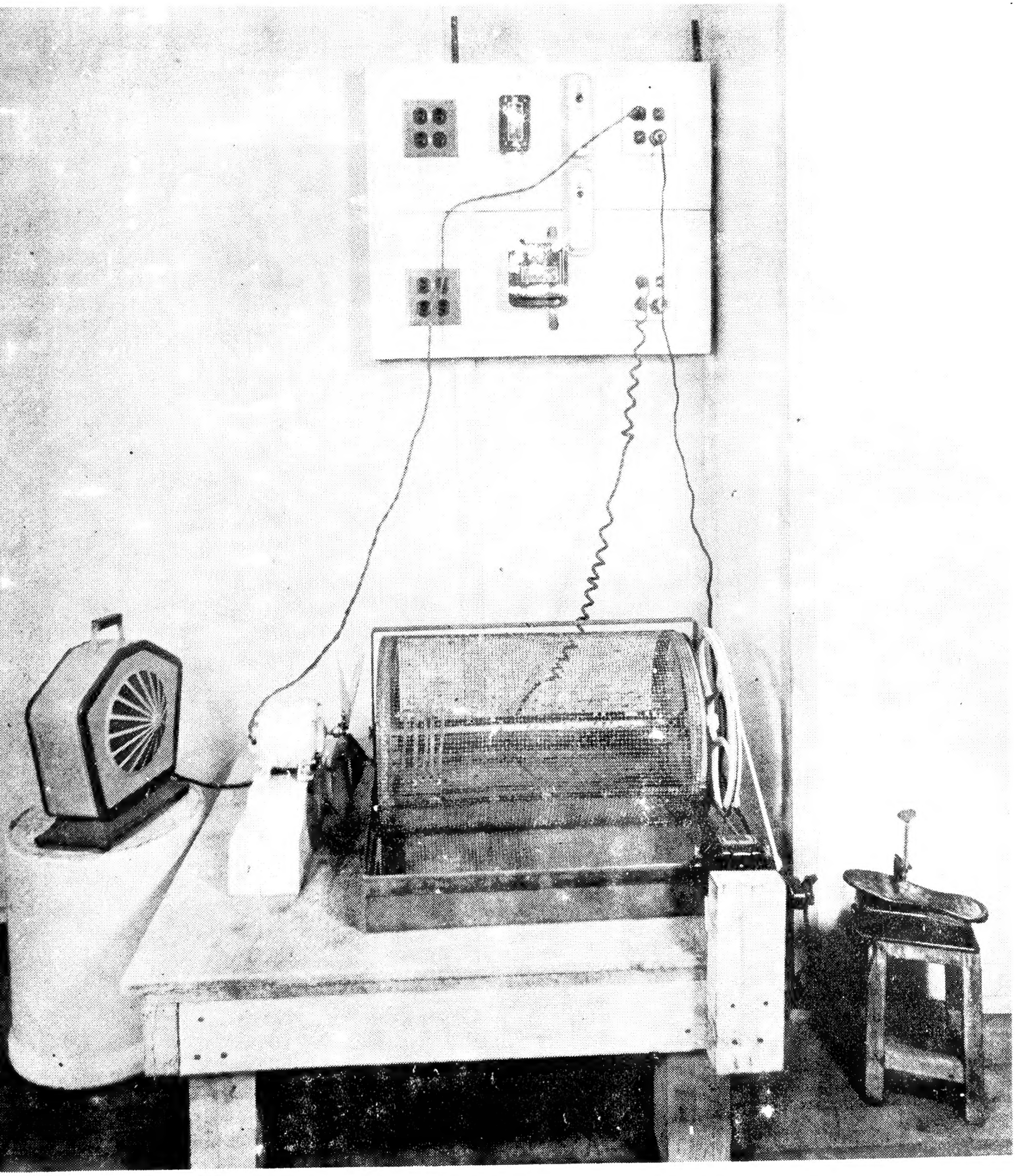

Figure 2.--View of assembled humidity and temperature apparatus in rearing room, showing humidistat and thermostat mounted on panel board above, small blower type electric heater at left, humidity apparatus in center, small motor at left center, and pedal switch at right.

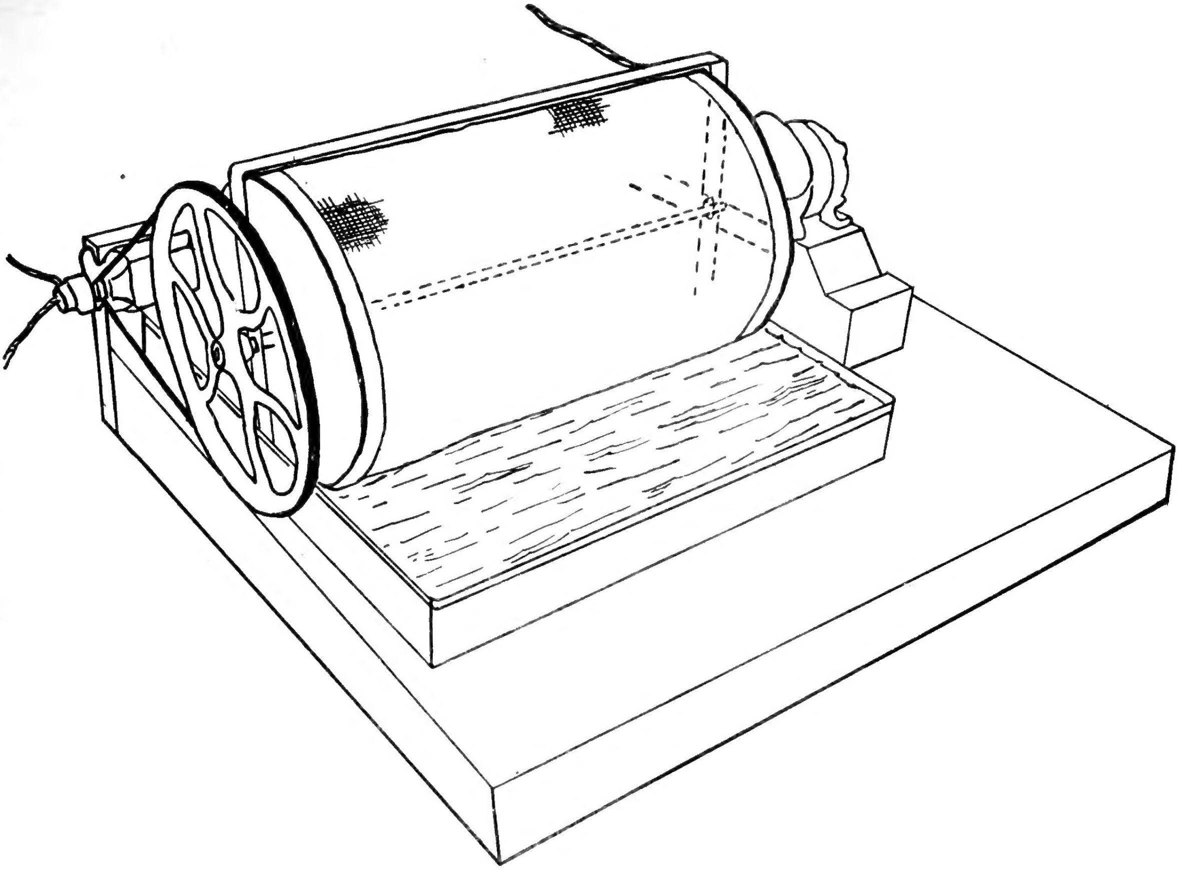

Figure 3.--Sketch of main element of humidity apparatus.

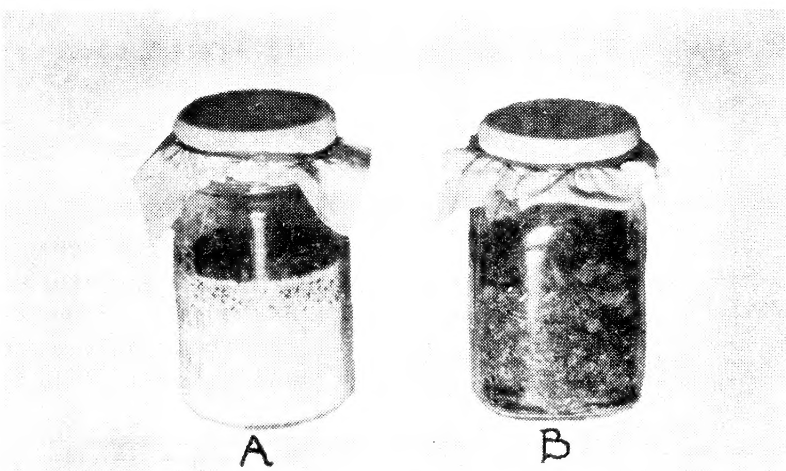

Figure 4.--Containers used in rearing the cigarette beetle (A) on whole corn meal and (B) on unmanufactured tobacco.